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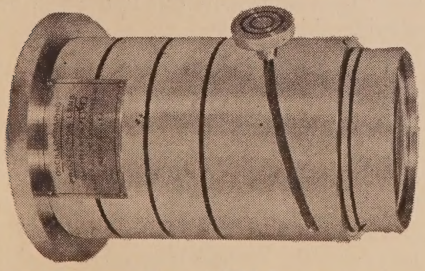
TYPE 2088 PROJECTION LENS

By CARL BERKLEY

The Du Mont Type 2088 Projection Lens was developed to fill the need for a comparatively inexpensive projection system, enabling standard, high-voltage oscillographs to be used for lecture and demonstration purposes before large groups. It is designed primarily for use with Du Mont oscillographs employing the Type 5RP-A cathode-ray tube, such as the Types 247-A, 248-A and 281. The lens mount has been standardized so that it will fit directly in the mounting holes provided for this purpose in these cathode-ray oscillographs without any modification.

The two primary requirements for any projection system are an intense image source and an efficient optical system. The first requirement is met by using the Type 5RP-A tube and the Du Mont Type 263-A High-Voltage Power Supply. The second requirement could be met previously only by the use of high aperture, long focal-length photographic lenses of extremely expensive construction. While these lenses did the job, they were usually much better in definition and angular field coverage than is required for oscillographic patterns, in which the resolution is generally much less than in optical systems. These complex lenses had one drawback. The fine corrections are obtained by the use of a large number of glass elements having cemented and air surfaces. The cement yellows with age while the glass-air surfaces reflect back some of the entering light. Both of these factors tended to decrease the overall efficiency of the system.



The Du Mont Type 2088 Projection Lens

These problems have been solved in the design of the Type 2088 Projection Lens by employing the simplest type of lens system that would give the required performance. The reflection and absorption losses are kept low by the use of only two thin elements of selected clear glass resulting in only four glass-air surfaces and no cemented surfaces. These elements are used in a symmetrical lens in which the distortion and lateral chromatism are kept to a minimum by careful choice of element spacing in the lens mount. The zonal spherical aberration is kept to a minimum by locating the aperture stop at the surface of one of the elements, which position was found to be best in connection with the Type 5RP-A tube. The curvature of field is excellent for such a simple lens. This is due to the fact that the object (the cathode-ray tube image) lies beneath

the face of the Type 5RP-A tube which is approximately 1/4 inch thick. This would tend to give a curved field because of the optical effect of the faceplate when used in connection with a perfectly corrected lens, but here it results in a flattening of the field, making an area of 3 by 3 inches usably sharp. A larger area may be used at somewhat decreased resolution. The resolution in the center of the projected pattern is adequate to resolve the finest oscillographic-pattern detail.

The Type 2088 Projection Lens has a focal length of 7.7 inches and a relative aperture of f/3.3 at infinity. The size of the projected image is given by the formula:

$$\text{Image Size} = \text{Size of Pattern on Cathode-Ray Tube} \left(\frac{\text{Projection Distance (in.)}}{7.7} - 1 \right)$$

the distance being measured from the focusing knob. The lens and focusing mount are designed to be used for any projection distance from eight feet to infinity. The largest size which can readily be seen depends on the efficiency of the fluorescent screen material in the cathode-ray tube and the ambient light which reaches the observer's eye. Since the eye can readily detect a brightness difference of ten per cent at all brightness levels, the size of the image which can be seen is directly proportional to its absolute brightness, which varies with the area it covers. In practice, in a darkened room, clear images up to 20 by 20 feet have been obtained, using a Du Mont Type 286 High-Voltage Power Supply delivering 25 kilovolts. This is sufficient for the largest auditoria. Ten kilovolts provided by the Type 263-A Power Supply is generally suitable for most requirements.

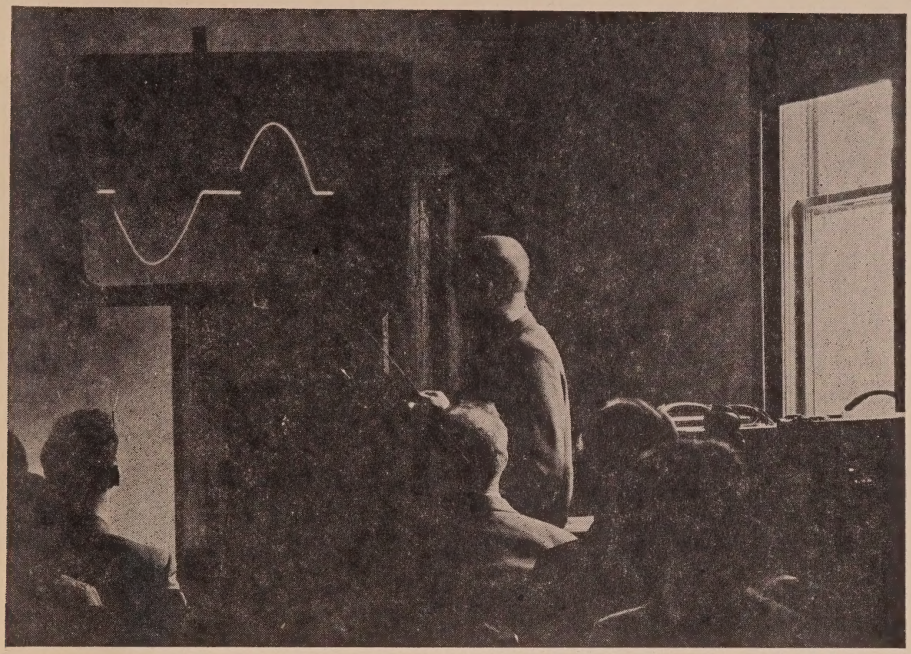
Transient Phenomena

The visual brightness of the projected image is essentially independent of frequency for repetitive phenomena of frequency higher than approximately 50 cycles per second. When lower frequencies are to be projected, flicker will become evident. This flicker cannot be eliminated in projection by the use of long-persistent screens, since the persistence is lowered due to the instantaneous heating of the screen material by the high energy of the beam. Some advantage may be obtained, in particular cases, by the use of special phosphor-coated projection screens used in perfectly dark rooms and by using a Type 5RP11-A tube. The projection screen is coated with a phosphorescent material similiar to that used in the long-persistent P7 screen. This material is especially sensitive to the light wavelengths emitted by the P11 phosphor and is photoexcited by the image projected upon it. If this image is repetitive, the phosphorescence increases to a value such that the image remains visible in a dark room for several minutes after removal of the excitation. Inquiry as to the uses of such screens should be directed to the Allen B. Du Mont Laboratories, Inc., Clifton, New Jersey.

For most general projection work a Type 5RP2-A tube should be used in a projection ocsillograph due to the high efficiency of the P2 phosphor at high accelerating voltages. Where transients such as damped oscillations or speech, for example, are to be projected, a Type 5RP2-A tube is to be specified. The limit writing rate with a P2 screen for a single transient using a Type 2088 lens on a Du Mont Type 247-A cathode-ray oscillograph with a Type 286 High-Voltage Power Supply has been found to be 30 kilometers per second referred to the size on the projection screen. This corresponds to a sine-wave image having a frequency of 10 kc and a peak-to-peak amplitude of two feet. This figure can be obtained in a perfectly dark room with dark-adapted observers. If any ambient light is present this figure will be considerably reduced.

Directive Projection Screens

The overall visual efficiency of the projected picture can be improved considerably by the proper use of a directive projection screen such as the "beaded" or "dark" screens. Only a certain definite light flux leaves the lens from the cathode-ray tube. If this flux is scattered to the walls or ceiling



Operation of a Projection Oscillograph in a Well-Lighted Room.

of the auditorium, it is wasted. The purpose of a directive screen is to direct this light toward the area of the room where the observers are located. If a high-efficiency screen is used, it is then possible to permit considerable ambient light in the room. Care should be taken, however, to keep light from falling directly on the projection screen, as this lowers the contrast of the resulting image. The above photograph shows the clarity of image that may be expected with the proper operating conditions in a well-lighted room. The lecturer can then easily adjust his apparatus without having to turn the lights out in order to show the resulting pattern.

References

1. Henny and Dudley, "Handbook of Photography," p. 227, McGraw-Hill.

2. Hardy and Perrin, "Principles of Optics," pp. 101-111, McGraw-Hill.

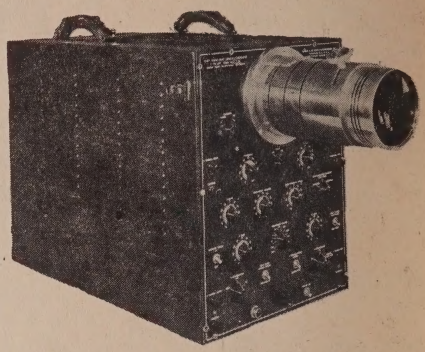
3. Rolf Möller, "Der Linsenrasterschirm" (The Lens Raster Screen) Fernseh Mitteilungen—April, 1939.

Specifications

Optical	
Focal Length	7.7 inches
Relative aperture (infinity)	f/3.3
Axial light transmission	85% approx.
Projection distance	8 feet or more
Usable tube area	3 x 3 inches
Physical	
Length—Adjustable by Focus Knob	7¾—11½ inches
Outside Diameter—	
Outer Barrel	5½ inches
Mounting Flange	6 23/32 inches
Weight	4½ pounds

REPLACEMENT OF THE DU MONT TYPE 233 CATHODE-RAY OSCILLOGRAPH

With the advent of the projection oscillograph and its ability to produce large-screen pictures from a small portable unit, the Du Mont Type 233 Cathode-ray Oscillograph using a 20-inch cathode-ray tube has been superseded. It may be advantageously replaced by the Du Mont Type 247-A oscillograph, plus a Type 2088 lens and either a 10 kv Type 263-A Power Supply or a 25 kv Type 286 Power Supply. Therefore, the Type 233 Oscillograph will no longer be manufactured. The Type 247-A—Type 2088 combination has the advantages of low cost, ready portability and greater pattern and audience size.



The Du Mont Type 2088 Lens Mounted on a Type 247-A Cathode-ray Oscillograph.

NEW PLANT

In early October of this year Du Mont consolidated its research and development departments and facilities for instrument and television manufacture in the recently acquired Clifton plant. Tube engineering and manufacture, however, are still carried on in the Passaic plant.

The two buildings shown in the photograph below provide an area of approximately 150,000 square feet for manufacturing and general offices. The new site extends over an entire city block of approximately seven acres. The address of this new plant is 1000 Main Avenue, Clifton, N. J.

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